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Gene action and combining ability studies for earliness in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract

Eight diverse genotypes were crossed in all possible combinations excluding reciprocals to identify the best parental combination. The analysis of variance postulated highly significant variances for general and specific combining ability for both the characters. The magnitude of general combining ability variances was higher than the specific combining ability variances. The parents IC-9856, Harbhajan and Pusa Sawani were identified as good general combiners for earliness. The crosses, PSN x ABY, IC-9856 x PKT, IC-9856 x ANK and IC-39135 x ANK and IC–39135 x Harbhajan can also provide good opportunity for selection of desirable segregates. Therefore, the parents IC-9856, Harbhajan and Pusa Sawani may be utilized in hybridization programme to develop early hybrids / cultivars of okra. The segregating generation of crosses involving good combining parents will further be advanced to produce early transgressive segregants followed by one or two intermatings like recurrent selection.

Key words: Okra [*Abelmoschus esculentus* (L.) Moench], gene action, combining ability, earliness.

Introduction

In okra, earliness is an important attribute. Early genotypes are advantageous in terms of producing early yield in the season resulting in better market price to the growers. Combining ability and gene action for earliness in okra have been reported earlier by Dhillon and Sharma (1982), Partap *et al.* (1982) and Metwally and El-Sawy (1988). At Palampur, the work is in progress to develop early maturing genotypes of okra. In this paper, results pertaining to combining ability and gene action for earliness are presented and breeding materials and methodology for developing early genotypes of okra have been discussed.

Material and Methods

Eight parents viz., IC-9856, IC-39135, P-7, Parbhani Kranti, Harbhajan, Pusa Sawani, Arka Abhay and Arka Anamika; 28 F_1's and 28 F_2's developed through Diallel Mating Design II were used in the present investigation at experimental farm of the Department of Vegetable Science, Himachal Pradesh Krishi Vishvavidyalaya, Palampur (32°6'N and 76°3'E at an elevation of 1290.8 meters above mean sea level) located in a sub temperate region. The parents and F_1's were grown in two rows while F_2's were grown in four rows of 2.0 m length. The inter- and intra- row spacing were 45 cm and 10 to 15 cm, respectively. The observations were recorded for days to 50% flowering and number of days to first picking. The genetic component analysis of Hayman (1954) and combining ability analysis of Griffing (1956) was followed with reference to the Model II Method 2.

Results and Discussion

The combined analysis of variance revealed significant differences both in the F_1 and F_2 generations for both the characters namely, days to 50% flowering and first picking indicating that the parents and crosses used in the present study were genetically diverse with respect to earliness. The t^2 test of homogeneity of variances over the arrays did not show significance for the traits studied suggesting thereby the assumptions involved in diallel were, in general, fulfilled. The regression coefficient ((bWr/Vr) and its deviation from unity inferred the presence of non-allelic interaction in F_1 and all the basic assumptions appeared to be satisfied in F_2 in both the traits.

The additive (D) and non-additive (H_1) components of genetic variance were significant for both the characters in both the generations except in F_1 for days to first picking (Table 1). However, the magnitude of additive and non-additive genetic component was more in F_1 generation except additive genetic component in F_1 in days to first picking. Sharma and Mahajan (1978) and Partap *et al.* (1980) reported the importance of both additive and non-additive genetic variance for these traits.

The magnitude of non-additive genetic variance was higher than that of additive genetic variance thereby suggesting the feasibility of heterosis breeding. The magnitude of h^2 was lower than that of H_1 and H_2, except for H_2 in F_1 for days to 50% flowering. The F value was non-significant which was further confirmed by the KD/KR ratio which exceeded the unity.

The degree for dominance was in over dominance range in both the traits in F_1 and F_2 generations. The ratio of $H_2/4H_1$ revealed the symmetrical distribution of negative and positive alleles among the different parents, as the ratio was near to the expected value of 0.25. Similar results were obtained by Arora (1979) and Korla (1985). The ratio of KD/KR was more than unity in both the generations indicating excess of dominant alleles in the expression of these traits which was also confirmed by the positive F-values, substantiated the findings of Korla (1985) and Veeraragavathatham and Irulappan (1990). The heritability estimates in narrow sense was quite high (42.2 to 50.3 per cent). The correlation coefficient

Table 1. Estimates of genetic components of variation and some proportional values

Genetic component	Days to 50% flowering		Days to first picking	
	F_1	F_2	F_1	F_2
D	8.47* ± 2.1	8.7* ± 2.2	3.9 ± 2.3	4.5* ± 0.6
H_1	16.2* ± 4.7	11.1* ± 5.1	24.3* ± 5.2	5.7* ± 1.5
H_2	14.5* ± 4.1	10.5* ± 4.4	22.4* ± 4.5	5.1* ± 1.3
h^2	16.2* ± 2.8	0.19 ± 3.0	8.2* ± 3.0	3.9* ± 0.9
F	4.0* ± 0.7	4.8 ± 5.3	0.59 ± 5.3	1.9 ± 1.5
E	1.8 ± 4.9	1.5* ± 0.7	1.4 ± 0.8	0.8 *± 0.2
$(H_1/D)^{1/2}$	1.38	1.1	$	1.13
$H_2/4H_1$	0.22	0.2	0.2	0.22
KD/KR	1.4	1.6	1.1	1.46
h^2/H_2	1.1	0.02	0.37	0.76
r(Wr+Vr)/Vr	- 0.36	- 0.14	- 0.60	0.60
bWr/Vr	0.21 ± 0.3	- 0.45 ± 0.55	0.15 ± 0.20	0.7 *± 0.23
1-bWr/Vr	*	NS	*	NS
t^2	0.4	0.84	3.38	0.20
h^2(n.s)	42.2	50.2	$	50.3
h^2(b.s)	82.5	82.4	85.4	82.5

Significant at P = 0.05; $ - Not computed as D was non-significant; NS- Non significant.

between parental (Yr) and parental order of dominance (Wr + Vr) was non-significant which implied that dominant genes were equally increasing and decreasing in effects among the parental lines. Similar results were found by Veeraragavathatham and Irulappan (1990). To exploit dominance alongwith epistasis use of pedigree method in early generation will be a futile exercise. This type of gene action observed in the present study can be best used by developing hybrids.

The data were further subjected to combining ability analysis. In both the traits, maximum negative and positive gene effects were observed in IC-9856 and Parbhani Kranti, respectively suggesting that the former was earliest in flowering and picking, while Parbhani Kranti was late. The parents IC-9856, Harbhajan and Pusa Sawani were good general combiners for earliness in flowering as well as picking. The inconsistency in the GCA effects in the F_1 and F_2 generations may be attributable to cancellation of genic effects in one or the other generation (Gardner and Eberhart, 1966). The negative SCA is desirable for breeding earliness in okra. The crosses IC-9856 x Parbhani Kranti, IC-39135 x P-7, Parbhani Kranti x Arka Abhay and Pusa Sawani x Arka Abhay exhibited significant negative SCA effects for both the characters in F_1 generation only, which is quite possible due to segregating effect (Table 3). The perusal of Table 2 and 3 revealed that the GCA effects of parents influenced the SCA effects of the hybrids.

Table 2. General combining ability effects for earliness

Parents/Traits	Days to 50% flowering		Days to first picking	
	F_1	F_2	F_1	F_2
IC – 9856	- 2.5*	- 1.7*	- 2.1*	- 1.5*
IC – 39135	0.6	0.9*	- 0.7	- 0.4
P - 7	- 0.2	- 0.7	0.4	- 0.7*
Parbhani Kranti	1.5*	1.4*	1.5*	1.3*
Harbhajan	- 1.0*	- 1.6*	- 0.4	- 0.1
Pusa Sawani	- 0.3	- 0.04	0.2	- 0.1
Arka Abhay	0.5	1.0*	0.4	1.0*
Arka Anamika	1.5*	0.7	1.1*	0.5*
SE (gi) ±	0.4	0.4	0.4	0.3

Significant at P = 0.05

Table 3. Specific combining ability effects for best crosses for earliness

Crosses/ Traits	Days to 50% flowering		Days to first picking	
	F_1	F_2	F_1	F_2
IC – 9856 x PKT	- 2.9*	-0.9	- 2.7*	0.1
IC – 9856 x ANK	3.1	0.2	5.1	- 1.7*
IC – 39135 x P- 7	- 3.3*	1.3	- 1.7	0.8
IC – 39135 x PKT	0.5	- 4.8*	- 0.8	- 2.9*
IC – 39135 x HBN	0.2	- 1.4	- 0.9	- 1.8
IC – 39135 x ANK	0.1	- 3.7*	- 0.7	- 1.8*
PKT x ABY	- 2.2	2.5	- 3.2*	0.5
PSN x ABY	- 1.3	- 1.1	-2.7*	- 2.0*

Significant at P = 0.05

The hybrids involving good general combining parents have also good SCA effects. In PSN x ABY, IC - 9856 x PKT, IC-9856 x ANK and IC-39135 x HBN, one early parent is involved. Such crosses offered good opportunity for selection of desirable segregates in the later generations. Similarly, in crosses, IC-39135 x PKT, IC-39135 x ANK and IC-39135 x Harbhajan, the significant negative SCA effects were found in F_2 segregating generation which can also provide good opportunity for selection of desirable segregates.

Thus the parents IC-9856, Harbhajan and Pusa Sawani may be utilized extensively in hybridization programme to develop early hybrids / cultivars of okra. The segregating generations of crosses involving good combining parents will further be advanced to produce early transgressive segregants by adopting single seed descent method or single fruit descent method followed by one or two intermating like recurrent selection. The use of population improvement as an alternative to conventional methods to exploit both additive and non-additive gene effects. Partap *et al.* (1982) also involved early parents to produce transgressive segregants for earliness.

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